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496

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Berlin, Juni 2005

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IMPRESSUM

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ISSN print edition 1433-0210
ISSN electronic edition 1619-4535

Tariffs and Firm-Level Heterogeneous Fixed Export Costs

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May 2005

Abstract

Recent literature on the workhorse model of intra-industry trade has explored heterogeneous cost structures at the firm level. These approaches have proven to add realism and predictive power. This note shows, however, that this added realism also implies that there may exist a positive bilateral tariff that maximizes national and world welfare. Applying one of the simplest specifications possible, namely a symmetric two-country intra-industry trade model with fixed export costs that are heterogeneous across firms, we find that the reciprocal reduction of small tariffs reduces welfare.

JEL: F12, F13, F15
Key Words: Optimal tariff, welfare, intra-industry trade, monopolistic competition, protectionism

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Acknowledgments: We wish to thank Marc Melitz for helpful comments and clarifying discussions. The usual disclaimer applies. Philipp J.H. Schröder gratefully acknowledges financial support by the Danish Social Sciences Research Council.

1 Introduction

Recently firm-level heterogeneity has been introduced to intra-industry trade models, e.g. Schmitt and Yu (2001), Melitz (2003), Helpman, Melitz and Yeaple (2004) or Yeaple (2005). These specifications, where firms are heterogeneous with respect to their cost structures, have provided important new insights, frequently reconciling theory with the stylized facts of international trade. For example Schmitt and Yu (2001) resolve the puzzle of scale economies and the volume of intra-industry trade by introducing firm-level heterogeneous fixed exporting costs. Melitz (2003) features firm-level heterogeneous marginal costs and analyzes intra-industry reallocations, showing that additional gains from trade stem from the induced productivity improvements. Helpman, Melitz and Yeaple (2004) introduce various firm-level heterogeneities in trading costs and are able to capture the exporting-versus-FDI decision of firms. Finally, Yeaple (2005) derives firm heterogeneity from labor force heterogeneities and arrives at realistic predictions concerning the productivity of exporting firms and the effects of trade on the skill premium.

However, thus far the literature has not fully examined the effects of these new – and more realistic – assumptions on the welfare effects of trade policies such as tariffs.[1] In this paper, we examine this issue in a simple symmetric two-county Krugman-type (1980) intra-industry trade model, while introducing firm-level heterogeneous fixed costs of exporting as in Schmitt and Yu (2001)[2] and a bilateral ad valorem tariff. The present model assumes that all tariff revenues and firm profits are redistributed in a lump sum fashion to consumers, that there are no wasteful (e.g. iceberg) trade costs, and that the firm-specific fixed costs of exporting are less than the cost of creating a new variety. We show that in this model there is in fact too much trade in the free trade equilibrium. More resources are used on the exporting/importing activity than is welfare-optimal, measured as total consumer utility. National and world welfare increases when imposing small bilateral tariffs. The optimal tariff is strictly positive, less than 1 and increases in the degree of product differentiation (love of variety). Thus, reciprocal trade liberalization, in particular the reduction of small tariffs, will be welfare-reducing. The underlying mechanism is that even though small bilateral tariffs reduce the number of traded varieties, the total number of available varieties in both

[1]Melitz (2003), Falvey, Greenaway and Yu (2004) and Baldwin and Forslid (2004), examine the welfare effects of reducing iceberg and fixed export costs in a Melitz-type (2003) setting with firm-level heterogeneous marginal costs.

[2]Earlier, Venables (1994) introduced homogeneous fixed costs of exporting into an intra-industry trade model and showed that already this extension of the standard model commanded additional realism by featuring exporters and non-exporters in equilibrium.

countries increases. Any tariff reduces the number and volume of traded varieties. For a small tariff fairly inefficient exporters cease their trading activity, and paired with the volume reduction, the total of saved resources more than compensates consumers via the entry of home varieties. The flip-side of this effect is of cause, that trading firms, since entry/exit decisions are based on home market performance, actually make profits. However, there is a volume-variety trade-off. Beyond the optimal tariff, a further increase in the tariff further reduces the import/export volume of all remaining trading firms and forces fairly efficient exporters out of the trading activity, replacing cheaply generated varieties (i.e. imported from abroad) with expensively generated varieties (i.e. produced at home).

The finding of welfare-reducing tariff liberalization contradicts much of the existing literature, see e.g. Markusen and Venables (1988), Fukushima and Kim (1989), Lockwood and Wong (2000). Also, in intra-industry trade models, bilateral tariffs are usually welfare-reducing, e.g. Gros (1987), Jørgensen and Schröder (2005).[3] The central difference between these models and the present model is that the earlier work assumes firms to be homogeneous in their cost structure. However, Melitz (2003), Falvey, Greenaway and Yu (2004) and Baldwin and Forslid (2004), all using a Melitz-type (2003) framework with firm-level heterogeneous marginal costs, examine, inter alia, iceberg trade cost reductions, which are often interpreted to represent trade liberalization, and find, in line with earlier literature, an overall welfare gain. Furthermore, Melitz (2003) and Baldwin and Forslid (2004) emphasize the possibility for an anti-variety effect. Yet, this situation, in contrast to the anti-variety effect in the present model, only emerges once the fixed costs of exporting are larger than the fixed costs of pure domestic production, and thus the export activity of a firm ties up more resources than an additional domestic variety would require. This situation is explicitly ruled out in the present model. The possibility of welfare-reducing trade liberalization is, however, found in Montagna (2001), in a framework where firms have heterogeneous marginal costs. Yet, a welfare loss occurs as a special case when trade allows relatively inefficient firms to enter and when consumers' taste for variety is sufficiently low.

The next section presents the model. In Section 3, we derive the welfare effect of imposing bilateral ad valorem tariffs, and discuss the results. Section 4 concludes.

[3]The same goes for other bilateral trade barriers such as quotas, real trade costs, technical barriers, etc; see e.g. Gros (1987), Schröder (2004). On the other hand, small unilateral tariffs may increase welfare (Gros, 1987), and unilateral tariffs can induce a home market effect in the presence of transportation costs (Helpman and Krugman, 1989).

2 The Model

The starting point is a standard Krugman-type (1980) model of intra-industry trade, yet with the feature of firm-level heterogeneous fixed costs of exporting as in Schmitt and Yu (2001). Consumers in two identical countries, home and foreign, love variety and have identical preferences, in which all consumption goods, c, enter symmetrically. Utility is given by

$$\begin{aligned} U &= \sum v(c_i) \\ &= \sum c_i^{\theta} , \quad \theta \in (0,1) . \end{aligned} \tag{1}$$

More specifically we can write (1) as

$$U = \sum_{i_d=1}^{N_d} c_{d,i_d}^{\theta} + \sum_{i_t=1}^{N_t} c_{t,i_t}^{\theta} + \sum_{i_f=1}^{N_f} c_{f,i_f}^{\theta} , \tag{2}$$

where c_{d,i_d} is consumption of variant i_d of non-exported domestic products, c_{t,i_t} is consumption of variant i_t of the exported domestic products and c_{f,i_f} is consumption of variant i_f of imported products.[4] The number of variants actually produced (n_d, n_t, and n_f) is assumed to be large, although smaller than N_d, N_t and N_f. Furthermore, denoting foreign variables by *, the symmetry of the setup implies $n_t = n_f^* = n_f = n_t^*$ and that trade is balanced.

Firms can produce their specific variant for the home market alone or for both the home and foreign market. The decision to export is firm-endogenous, where some but not all firms will export. Each firm produces with the same constant marginal cost β and a fixed cost α, both expressed in terms of labor, L, which is the only factor of production and is remunerated at the economy-wide wage rate w. When exporting, a firm faces an additional firm-specific fixed export cost, a_i, heterogeneous across firms and, for simplicity, assumed to be uniformly distributed on support $a_i \in (0, \alpha)$, with $F(.)$ denoting the distribution function. Furthermore, both countries charge the same ad valorem tariff $\tau \in (0,1)$ on imports, i.e. a bilateral tariff. The presence of fixed export costs and the tariff creates an asymmetry between trading and non-trading firms, and hence, the profit functions of a pure domestic firm only servicing the home market, and an exporting home firm servicing both markets, are

$$\pi_d = p_d x_d - (\alpha + \beta x_d) w \tag{3}$$

$$\pi_z = p_t x_t + (1-\tau) p_z x_z - (\alpha + a_i + \beta(x_t + x_z)) w , \tag{4}$$

[4] Since all goods enter symmetrically and since all firms behave identically within the two categories trading and non-trading, we can omit subscript i where unnecessary.

where x_d is the production of a pure domestic firm, and x_t and x_z are the output of an exporting firm to the home and the foreign market respectively. Finally, various market-clearing relations complete the model: labor market clearing, $n_d(\alpha + \beta x_d) + n_t(\alpha + \beta(x_t + x_z)) + \sum a_i = L$; goods market clear $Lc_{d,i_d} = x_{d,i_d}$, $Lc_{t,i_t} = x_{t,i_t}$ and $L^* c^*_{f,i_f} = x_{z,i_t}$, where the foreign index i_f and the home index i_t denote one and the same variant; income expenditure clearing $Lw + R = p_d x_d n_d + p_t x_t n_t + p_f x_f n_f$, where R denotes the profits of all domestic firms and all tariff revenues assumed to be lump-sum redistributed to consumers; and similar relations for the foreign country.

Non-trading firms

Maximization of (2) leads to the familiar inverse demand functions, e.g. $p_d = \frac{\theta c_d^{\theta-1}}{\lambda}$ for any non-traded home good i_d, and similar for traded products, given that the number of products is large. Then, profit maximization of (3) results in the price

$$p_d = \frac{\beta w}{\theta} \; . \tag{5}$$

Given free entry and exit, there are zero profits for non-trading firms in equilibrium and accordingly, the per-firm output volume is:

$$x_d = \frac{\alpha\theta}{(1-\theta)\beta} \; . \tag{6}$$

In the absence of international trade, the autarky number of firms is determined by labor market clearing $n_d(\alpha + \beta x_d) = L$ and turns out to be $n_d^a = \frac{L(1-\theta)}{\alpha}$.

Exporting firms

Maximizing (4) with respect to x_t and x_z, the price decisions of a trading firm are

$$p_t = \frac{\beta w}{\theta} \tag{7}$$

$$p_z = \frac{\beta w}{(1-\tau)\theta} \tag{8}$$

for sales on the home and the foreign market respectively.[5] Since $p_t = p_d$ consumers do not distinguish between non-traded home products and traded

[5] Here, we follow Schmitt and Yu (2001), where trading firms reach breakeven on their home market operation. Different entry decision mechanisms are conceivable, e.g. as in Melitz (2003) where firms determine their entry subject to some sunk investment.

home products; and hence, sales of trading firms on their home market must be:

$$x_t = x_d = \frac{\theta\alpha}{(1-\theta)\beta} \; . \tag{9}$$

Sales of home firms on the foreign market – and import sales by foreign firms on the home market – are different. Note that $p_z = \frac{p_d}{1-\tau}$, i.e. exported goods are more expensive than domestically produced goods and that by symmetry $p_z = p_z^*$, i.e. the price that a home firm charges abroad is the same as the price charged by foreign exporters on our home market. In equilibrium, maximization of utility (2) requires that the ratio of the marginal utility of an extra consumption unit equals the price ratio, i.e. $\frac{\theta c_d^{\theta-1}}{\theta c_f^{\theta-1}} = \frac{p_d}{p_z^*} = 1-\tau$. Utilizing the goods market clearing conditions, this implies

$$x_z = x_z^* = x_d(1-\tau)^{\frac{1}{1-\theta}} \; . \tag{10}$$

Thus exporting firms charge the same price on their home market and have the same sales volume as non-trading firms, but charge higher prices and sell less of their variety on the foreign market. By the same token, domestic consumers pay more and consume less of imported product varieties compared to domestically produced varieties.

The number of trading and non-trading firms

With the prices and quantities derived above, it is straightforward to identify the firm just indifferent between becoming an exporting firm and becoming a pure domestic firm. This firm is characterized by a fixed cost of exporting $\bar{a}$ such that it makes zero profits from the exporting activity. Solving from (4) for $(1-\tau)p_z x_z - (\bar{a} + \beta x_z)w = 0$, gives

$$\bar{a} = \alpha(1-\tau)^{\frac{1}{1-\theta}} \; . \tag{11}$$

Notice that by (11) we have $\bar{a} \in (0, \alpha)$, thus the indifferent firm is within the assumed range of a_i; and all firms i such that $a_i \in (0, \bar{a})$ make positive profits from exporting, while all firms i such that $a_i \in (\bar{a}, \alpha)$ are non-trading firms. Furthermore, $\bar{a}$ decreases in the tariff rate, implying that the least efficient (high a_i) firms will cease their trading activity in response to a tariff increase.

The total number of firms at home, $n = n_t + n_d$, is most easily determined via the labor market clearing condition. Utilizing the fact that the average fixed cost of exporting is given by $\bar{a}/2$, and that $n_t = F(\bar{a})n$ and $n_d =$

$(1-F(\bar{a}))n$ must hold, one gets:

$$n_d = \frac{L(1-\theta)}{\alpha} \frac{2-2(1-\tau)^{\frac{1}{1-\theta}}}{2+(1+\theta)(1-\tau)^{\frac{2}{1-\theta}}}, \quad (12)$$

$$n_t = \frac{L(1-\theta)}{\alpha} \frac{2(1-\tau)^{\frac{1}{1-\theta}}}{2+(1+\theta)(1-\tau)^{\frac{2}{1-\theta}}}, \quad (13)$$

$$n = \frac{L(1-\theta)}{\alpha} \frac{2}{2+(1+\theta)(1-\tau)^{\frac{2}{1-\theta}}}. \quad (14)$$

From (14) it can easily be seen that the total number of firms under trade is less than the number of firms in autarky, n_d^a. Yet because of trade, consumers also have access to foreign varieties, in particular due to symmetry $n_t = n_t^* = n_f$. Furthermore, under free trade ($\tau = 0$), all firms export and n_d in (12) becomes zero, while with prohibitive trade costs (e.g. $\tau = 1$) we are back in the autarky case, i.e. n in (14) becomes n_d^a.

3 Welfare results

All tariff revenues and firm profits are redistributed in a lump-sum fashion to consumers. Thus total consumer utility is a measure of welfare. Given goods market clearing and (2), we can write $\sum U = n_d x_d^\theta + n_t x_t^\theta + n_f x_f^\theta$, and setting in values from above and simplifying gives:

$$\sum U = \frac{L(1-\theta)}{\alpha} \left(\frac{\alpha\theta}{(1-\theta)\beta}\right)^\theta \frac{2+2(1-\tau)^{\frac{1+\theta}{1-\theta}}}{2+(1+\theta)(1-\tau)^{\frac{2}{1-\theta}}}. \quad (15)$$

Since $\frac{L(1-\theta)}{\alpha}\left(\frac{\alpha\theta}{(1-\theta)\beta}\right)^\theta$ in (15) is in fact the value of total consumer utility under autarky, we have a simple measure of the welfare gain from trade, namely

$$b = \frac{2+2(1-\tau)^{\frac{1+\theta}{1-\theta}}}{2+(1+\theta)(1-\tau)^{\frac{2}{1-\theta}}}, \quad (16)$$

which only depends on τ and θ. The following result emerges.

Proposition 1. *There exists a strictly positive bilateral tariff, $\hat{\tau}$, that maximizes the national welfare of both countries. In particular, $\hat{\tau} \in (0, \frac{1-\theta}{2})$.*

For proof, see appendix. To illustrate proposition 1, consider figure 1 which plots b as a function of τ for various values of θ. To the right, for τ close to 1 we are in the autarky situation, $b = 1$. To the left, for $\tau = 0$, we are in the free trade situation, and welfare in both countries is clearly above the autarky level ($b > 1$). However, imposing a small bilateral tariff increases welfare until we reach the optimal bilateral tariff, $\hat{\tau}$, beyond which welfare starts to decrease towards the autarky level. What proposition 1 implies is in fact that there is too much trade in the free trade situation. National and world welfare increases when imposing small bilateral tariffs. The optimal bilateral ad valorem tariff is strictly positive, less than 1 and increases in the degree of product differentiation, θ, (love of variety). Accordingly, trade liberalization, in particular the bilateral reduction of tariffs smaller than $\hat{\tau}$, will be welfare-reducing.

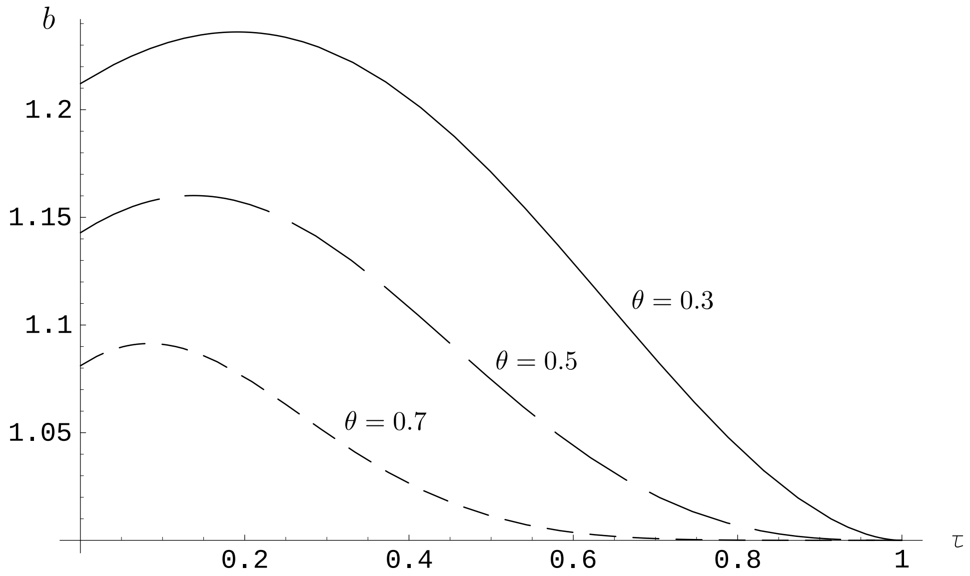

Figure 1: The welfare effect of bilateral tariffs

What drives this finding of a welfare-reducing effect of trade liberalization? To illustrate the intuition for the result it is useful to examine the number of firms given in (12) to (14) and the number of varieties available on the home market given by $\tilde{n} = n + n_f$. In Figure 2 we have set $L = 100$, $\alpha = 0.5$ and $\theta = 0.7$. What the figure reveals is that with the imposition of a small bilateral tariff, the exit of trading firms and therewith the loss of n_t and n_f is more than compensated by the entry of additional pure domestic firms n_d, thus increasing the total number of varieties available, $\tilde{n}$, and hence also utility.[6]

[6]For formal proof of the shape of $\tilde{n}$ see the appendix.

To see the logic of the welfare increase stemming from small bilateral tariffs, consider the following reasoning. A small bilateral tariff, reduces the number of imported varieties and – via the imposed price increase of foreign products – the import volume of all remaining varieties. However, overall a small tariff still increases welfare because the least efficient exporters are the first to cease their trading activity. Paired with the additional resources saved by reducing the trading activity of all remaining exporting firms, this frees enough resources for the production of more home varieties. The flip-side of this effect is of cause, that trading firms, since their entry/exit decisions are based on breakeven on their home market, actually make profits. Furthermore, there exists a volume-variety trade-off, that is the tariff reduces the volume of each remaining importer/exporter but converts it into additional domestic entry.[7] However, beyond the optimal bilateral tariff, $\hat{\tau}$, a further increase in the tariff further cuts imported volumes, and more importantly, it forces fairly efficient exporters out of the trading activity. Thus, additional variants produced relatively cheaply (i.e. by foreign exporters who have fairly low fixed export costs) are replaced with variants produced relatively expensively (i.e. by new home producers incurring the fixed production cost, α).

4 Conclusion

This paper examined the welfare impact of trade policy in an intra-industry trade model with firm-level heterogeneity. This new type of specifications, where firms are heterogeneous with respect to their cost structures, has generated important new insights, frequently reconciling theory with the stylized facts of international trade, e.g. Schmitt and Yu (2001), Melitz (2003), Helpman, Melitz and Yeaple (2004) or Yeaple (2005), but has not yet been used to systematically examine trade policies.

Our model examines bilateral ad valorem tariffs in a symmetric two-country intra-industry trade model, with firm-level heterogeneous fixed costs of exporting. We find that in this model there is in fact too much trade in the free trade equilibrium. More resources are used on the exporting/importing activity than is welfare-optimal, measured as total consumer utility. There exists a strictly positive bilateral tariff that maximizes national and world welfare. Accordingly, trade liberalization, in particular the reciprocal reduction of small tariffs, is welfare-reducing. This contradicts much – if not all

[7] The volume-variety trade-off can be seen by comparing Figure 2, which is plotted for $\theta = 0.7$ and shows the maximum number of available varieties at a tariff of approximately 20%, with Figure 1, which shows the welfare maximum for $\theta = 0.7$ at a tariff of approximately 10%.

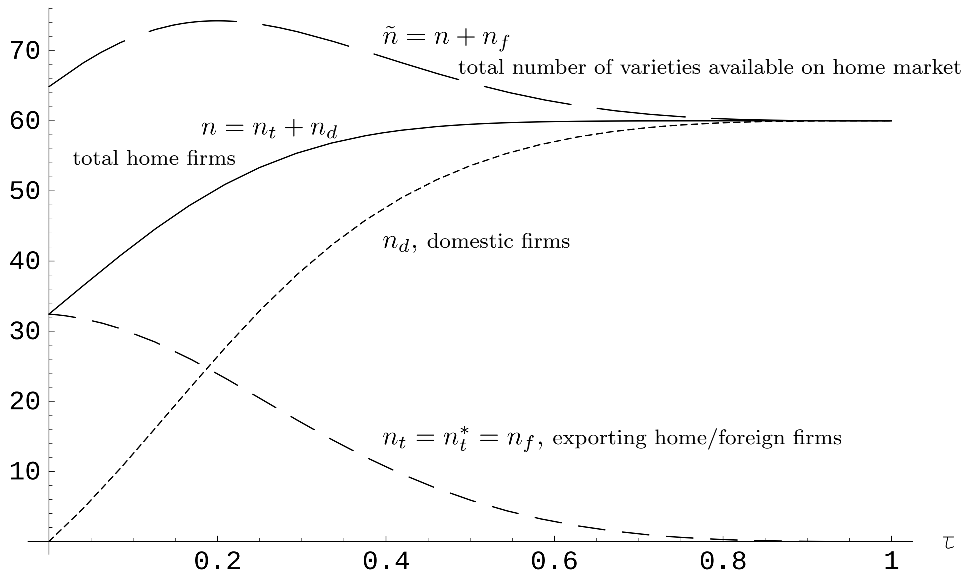

Figure 2: The number of firms and varieties with bilateral tariffs

– of the existing literature. The underlying mechanism for our result is that even though small bilateral tariffs reduce the number of traded varieties, the number of available varieties in both countries increases. This mechanism is at work even though the fixed costs of creating a new domestic variety are always larger than the firm-specific fixed costs of exporting and even though there are no wasteful (e.g. iceberg) trade costs. Future research should address the welfare effects of trade policies for different forms of firm-level heterogeneity, for different firm-entry decision mechanisms and for more types of trade barriers.

A Appendix

A.1 Proof of Proposition 1.

Proof. A small bilateral tariff increases welfare.
Differentiating the welfare gain, b, from (16) with respect to τ gives:

$$\frac{\partial b}{\partial \tau} = \frac{2(1+\theta)(\theta - 1 + 2\tau(1-\tau)^{\frac{2}{\theta-1}})}{(\theta-1)(1+\theta+2(1-\tau)^{\frac{2}{\theta-1}})^2(\tau-1)^2} \ . \tag{A.1}$$

Evaluating at $\tau = 0$ gives:

$$\frac{\partial b}{\partial \tau}|_{\tau=0} = \frac{2(1+\theta)(1-\theta)}{(1-\theta)(1+\theta+2)^2} > 0 \ . \tag{A.2}$$

□

Proof. Existence of a welfare-maximizing positive bilateral tariff, $\hat{\tau} \in (0, \frac{1-\theta}{2})$.
From (A.1),

$$\frac{\partial b}{\partial \tau} = 0 \quad \Leftrightarrow \quad \theta - 1 + 2\tau(1-\tau)^{\frac{2}{\theta-1}} = 0 \tag{A.3}$$

$$\Leftrightarrow \quad \tau + \tau^g \left(\frac{1}{g}\right)^g = 1 \ , \tag{A.4}$$

where $g = \frac{1-\theta}{2} < \frac{1}{2}$. Define $K(\tau) = \tau + \tau^g \left(\frac{1}{g}\right)^g$. Then:

$$K(0) = 0 \, , \tag{A.5}$$

$$K(g) = g + 1 > 1 \, , \tag{A.6}$$

$$K'(\tau) = 1 + g^{1-g}\tau^{g-1} > 0 \ , \forall \tau \in (0;1) \ . \tag{A.7}$$

Therefore, $\exists \ \hat{\tau} \ \in]0; g[$ where $K(\hat{\tau}) = 1$, and thus (A.4) is fulfilled. □

A.2 Proof of the shape of $\tilde{n}$.

Proof. Number of varieties under free trade is larger than under autarky.
From (14) and (13) the number of varieties available on the home market, $\tilde{n} = n + n_f$, is:

$$\tilde{n} = \frac{L(1-\theta)}{\alpha} \frac{2(1+(1-\tau)^{\frac{1}{1-\theta}})}{2+(1+\theta)(1-\tau)^{\frac{2}{1-\theta}}} \ , \tag{A.8}$$

Evaluating $\tilde{n}$ under free trade, $\tau = 0$, and under autarky, $\tau = 1$, gives:

$$\tilde{n}|_{\tau=0} = \frac{L(1-\theta)}{\alpha} \frac{4}{2+(1+\theta)}, \tag{A.9}$$

$$\tilde{n}|_{\tau=1} = \frac{L(1-\theta)}{\alpha}. \tag{A.10}$$

□

Proof. The number of available varieties increases for a small tariff.
The derivative of $\tilde{n}$ in (A.8) with respect to τ, is:

$$\frac{\partial \tilde{n}}{\partial \tau} = \frac{2\,L\,\left((1+\theta)+2\,(1+\theta)\,(1-\tau)^{\frac{1}{\theta-1}} - 2\,(1-\tau)^{\frac{2}{\theta-1}}\right)}{\alpha\left(1+\theta+2\,(1-\tau)^{\frac{2}{\theta-1}}\right)^2 (1-\tau)^{\frac{2-\theta}{1-\theta}}}. \tag{A.11}$$

Evaluating $\frac{\partial \tilde{n}}{\partial \tau}$ in the free trade situation, $\tau = 0$, gives:

$$\frac{\partial \tilde{n}}{\partial \tau}|_{\tau=0} = \frac{2L(1+3\theta)}{\alpha(3+\theta)^2} > 0, \tag{A.12}$$

and $\lim_{\tau\to 1} \frac{\partial \tilde{n}}{\partial \tau} = 0$. □

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